Citation:

Song Y, Manson JE, Buring JE, Liu S. A prospective study of red meat consumption and type 2 diabetes in middle-aged and elderly women: the Women's Health Study. *Diabetes Care.* 2004; 27(9): 2,108-2,115.

PubMed ID: 15333470

Study Design:

Prospective cohort study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To prospectively assess the associations between red meat and processed meat consumption and incidence of type 2 diabetes in a large cohort of US women.

Inclusion Criteria:

- Women who were free of coronary heart disease, stroke and cancer (other than non-melanoma skin cancer)
- Completed a 131-item semi-quantitative food frequency questionnaire (SFFQ)
- Written informed consent.

Exclusion Criteria:

- More than 70 items left blank in their SFFQ
- Total energy intake outside the range of 600 and 3,500kcal per day
- Reported diabetes at baseline.

Description of Study Protocol:

Recruitment

39,876 female health professionals aged 45 or more years were recruited from the Women's Health Study.

Design

8.8-year follow-up prospective cohort study.

Statistical Analysis

- Cox proportional hazards models were used to estimate the relative risks (RR) and 95% CI of developing type 2 diabetes for each meat item compared with the lowest category
- In multivariate models, age, BMI, total energy intake, smoking status, exercise, alcohol intake and family history of diabetes were adjusted and then dietary factors were further adjusted
- Tests of linear trend across increasing categories of intake were conducted by assigning the medians of intakes in quintiles treated as a continuous variable
- A likelihood ratio test was used to assess the significance of interaction terms.

Data Collection Summary:

Timing of Measurements

- Meat intake was measured by a 131-item validated SFFQ at baseline. The correlations between the SFFQ and two one-week diet records were established: 0.48 to 0.68 for total and specific types of fat intakes, 0.35 to 0.45 for meat and 0.33 to 0.53 for processed meat
- Participants were asked annually whether and when they had been diagnosed with type 2 diabetes. Accuracy of self-reported type 2 diabetes was validated by two approaches.

Dependent Variables

Number of incident cases of type 2 diabetes.

Independent Variables

Intakes of red and processed meat.

Control Variables

- Age, BMI, total energy intake, smoking status, alcohol intake, physical activity and family history of diabetes
- Dietary fiber, glycemic load, total fat and magnesium.

Description of Actual Data Sample:

- *Initial N:* 39,876 were recruited at study initiation
- *Attrition (final N):* 37,309 for the analyses indicating 6% dropout rate
- *Age:* Participants were aged 45 or more years at baseline in 1993
- *Anthropometrics:* Whether groups were significantly different on BMI were not indicated
- *Location:* Brigham and Women's Hospital at Boston, Massachusetts.

Summary of Results:

Key Findings

- 1,558 incident cases of type 2 diabetes were identified during 326,876 person-years of follow-up
- Positive associations were found between intakes of red meat and processed meat and risk of type 2 diabetes, after adjusting for age,BMI, total energy intake, exercise, alcohol intake, cigarette smoking and family history of diabetes

- Comparing women in the highest quintile with those in the lowest quintile, the multivariate-adjusted RR of type 2 diabetes were 1.28 for red meat (95% CI: 1.07 to 1.53, P<0.001 for trend) and 1.23 for processed meat (1.05 to 1.45, P=0.001 for trend)
- The significantly increased diabetes risk appeared to be most pronounced for frequent consumption of total processed meat (RR 1.43, 95% CI: 1.17 to 1.75 for five or more a week vs. less than one a month, P<0.001 for trend). Two major subtypes were bacon (1.21, 1.06 to 1.39 for two or more a week vs. less than one a week, P=0.004 for trend) and hot dogs (1.28, 1.09 to 1.50 for two or more a week vs. less than one a week, P=0.003 for trend). Results remained significant after adjustment for intakes of dietary fiber, magnesium, glycemic load and total fat
- Intakes of total cholesterol, animal protein and heme iron were significantly associated with a higher risk of type 2 diabetes.

Author Conclusion:

This study indicates that higher consumption of total red meat, especially various processed meats, may increase risk of developing type 2 diabetes in middle-aged and older US women.

Reviewer Comments:

- *This is a large prospective cohort observational study. It may be less of a concern if subjects were not a representative sample. I am not too worried that specific methods of handling withdrawals were not described because follow-up rates were quite high*
- *Food intakes should be evaluated multiple times throughout the study period, because dietary changes might occur overtime*
- *The validity of physical activity measure should be described in this study, since controlling confounding from this underlying lifestyle factor is critical.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes

4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	No
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	N/A
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes

7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes